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ABSTRACT

A validated instructional model generated on a large mainframe computer by the military was modified to a microcomputer format for use in programming tutorial computer assisted instruction (CAI) materials, and a simplified, compatible system of generating programs was identified--CP/M and MP/M from Digital Research Corporation. In order to overcome many microcomputer inter-system compatibility problems, a script generation model and dot command structure were also developed and adapted from a mainframe computer into the microcomputer. This system, used with a structured teaching model, simplifies the programming of materials for use with CAI in classroom teaching, allowing teachers to write their own CAI materials. In addition, 17 script guidelines are given to provide help in writing interactive scripts. This list includes the use of such techniques as (1) student controlled pace of instruction; (2) extensive use of information feedback; (3) providing test results to students; and (4) integration of verbal and hands-on training. Also provided is a lesson flow chart which includes a pretest, lesson sequence, and a posttest. The lesson sequence incorporates such elements as conditioning chains, multiple choice response frames, proven units, and review elements. The paper concludes with a collection of dot commands available in the management program ISSCAI, which was written to implement a usable microcomputer programming language for CAI, and an author's summary. (JB)

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SIMPLIFIED TUTORIAL PROGRAMMING FOR INTERACTIVE CAI

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INTRODUCTION

With the proliferation of microcomputers and the incompatibility of operating systems which control them, a simplified, compatible system of generating programs for tutorial CAI was needed. In examining the many types of computers, input/output devices and operating systems, one system in particular surfaced as the predominant one for microcomputers--CP/M and MP/M from Digital Research Corporation. In order to overcome many of the inter-system compatibility problems, a script generation model and dot command structure was developed and adopted to a CP/M-MP/M format on a microcomputer.

The restrictions of microcomputers for tutorial instruction are many. Limited memory capacity of the CPU, limitations in disk capacity for storage of multiple lessons or instructional programs, a variety of disk operating systems, each with its own version of a programming language and the large number of classroom teachers who are not programmers, have restricted the application of micros to elementary drill

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and practice routines, linear presentations, or simplified management and recordkeeping functions. With the development of a structured programming system which is capable of managing student progress through a learning experience in relation to aptitudes and other relevant personal information placed into the system prior to instruction, it is now possible to incorporate many of the individual branching and management features of a large mainframe system into a microcomputer (U.S. Continental Army Command, TR-72-1). Although many restrictions still exist for micro applications in tutorial instruction, the existence of a structured teaching model which can be easily followed by the classroom teacher and which simplifies programming of that material will provide for expanded use of CAI materials in the existing classrooms of todays schools (Jelden/Brown, 1982). This presentation will develop the educational model, show examples of how scripts can be written in line with the model and then show the simplicity of programming the instructional materials with the ISSCAI system's dot commands (Shaffstall, 1980). Characteristics of the system include security for the instructional program to minimize student cheating and some copyright problems, reduction of CPU memory capacity required to house lengthy, complex tutorial programs, comprehensive student progress reports, both for the testing and instructional modes and ease of student registration and instructor data entry. Let's begin by developing a theoretical base for the educational model used in the system.

THE EDUCATIONAL MODEL

Any good teaching/learning operation is only as effective as the interaction process between the teacher and student. The teacher's responsibility is one of assessing the individual characteristics of the students. It involves getting to know the background of each student in terms of learning strengths and weaknesses, their likes and dislikes, their past experiences and success or failure in formal learning previously accomplished. In short, it is the obligation of the teacher to know well the students they attempt to teach (Jelden, 1971).

There are many external student evaluation devices available to the teacher. Some can measure aptitudes, personality traits and the like, but from past experience these can, at best, only support what the personal perception of the teacher identifies in his/her day to day contact with the student. The best way to really get to know a student is to talk with them openly and honestly and try to convince the student that your main purpose as a teacher is to help simplify and reduce the "pain of learning." It is the mutual understanding between teacher and student that helps humanize the learning experience. The existence of the computer will only help the teacher do a better job of what they were already doing. The computer in no way will replace the teacher, only change the way that teacher and student might interact.

The other primary task of the teacher is to identify, order and prepare the content of the instruction in a manner which is acceptable to

the student and which meets the objectives of the teacher. The analysis of content materials in line with the best we know in educational theory and practice can simplify the preparation of CAI materials. Establishing a learning sequence from a logical/psychological order will provide for greater educational efficiency of the tutorial lesson. For example, teaching those tasks which are basic, appear most offten and are required for future activities is an example of logical order. The anlaysis of instructional content in the form of teaching the skills and knowledge easiest to learn first and delaying the more complex, difficult tasks until last is an example of psychological order. When the teacher prepares his/her tutotrial materials, applying both of these criteria will likely produce the most effective learning experience for the student and time efficient system for both.

It might be important at this point to realize that there are a wide variety of teaching/learning models in use today (U.S. Continental Army Command, TR-71-2). The utilization of discovery learning at the lower elementary level might prove to be more personally rewarding to the student. It has been shown, however, that as students mature and move into the junior/senior high programs, a more structured used in teaching the basics essential to high levels of competence is more effective. Students expect, and rightly so, the teacher to tell them what they are expected to learn. This attitude fostered the extensive use of performance or criterian objectives in educational programs over the last 15 years. The existence of this attitude from the students' point of

view makes the utilization of the computer a natural support system for the educational environment. Now, the student can ask the computer what they are expected to learn and do it at a time pertinent to student needs, wishes and interests. The computer does provide a truly individualized, self-pacing educational experience for the student (Jelden/Brown, 1982).

Once the content of a course is identified and ordered, it is then ready to be placed in some type of educational context. In CAI tutorial instruction, this process can be simplified by following some guidelines for script development. These guidelines might include general rules for program/text generation or something as formal as a flow chart which helps establish the structure of the learning experience. Let's first look at some general guidelines which practice has shown to be helpful in writing instructional materials. A greater indepth explanation of the model will then be more useful in writing the instructional sequence (Jelden, 1981).

General Script Guidelines

Based on classroom applications (Jelden, 1980) and student reactions, the following general criteria should be followed wherever possible. These items are in no particular rank order but have proven helpful in writing interactive scripts.

1. The content of instruction should be determined through content analysis and should be specified in terms of student performance objectives consisting of terminal performance and enabling objectives. Criteria of quantity or quality should be clearly described.
2. The pace of intruction should be controlled by the student to the extent possible which is consistent with effective educational practice.
3. Individual differences among students should be taken into account to provide the most effective and efficient learning paths in line with student aptitudes and needs.
4. Extensive use should be made of information feedback to assure response sensitive instruction.
5. The instruction should be presented in a modified single mainline track. Branching, looping and other techniques should be used to promote efficiency and effectiveness of instruction particularly for slow learners. Forward branching should be used to increase the efficiency of instruction for fast learners and others with prior knowledge of the subject matter.
6. A system should be established to evaluate student performance in terms of mastery of the objectives.
7. Knowledge of results should be provided to the student. Correct answers should be confirmed and incorrect responses should be followed by immediate remediation.

8. Progress to a new increment of intruction should not be permitted unless a correct answer is obtained from the prior question.
9. Students should be afforded the opportunity to recycle through those portions of the instruction in which failure to meet objectives is evident.
10. The mainline sequence of instruction frames should be designed to achieve 85% correct responses by all students on the first try. Achievement of this objective should be determined through analysis of student performance data by trial and error in sample programs. The program should be difficult enough to require thought and reasoning but cued or prompted in such a way to stand a good chance of being answered correctly.
11. Effective use should be made of the instructor to assist students who encounter difficult during instruction. The need for instructor assistance should be determined under program control by failure of the student to meet specified performance criteria. In addition, instructor assistance should be made available whenever requested by the student.
12. The instruction should consist of practical (hands-on) training to the extent dictated by the objectives.
13. Verbal and practical (hands-on) training should be carefuly integrated to provide variety in presentation modes and to avoid over-dependence on verbal comprehension for mastery of concepts and skills.

14. The major portion of the subject matter should be converted to CAI format. However, care must be exercised to avoid the use of CAI for instruction that can be presented just as effectively by more economical self-paced methods.
15. Liberal use should be made of graphics, diagrams, schematics, pictures, etc., in conjunction with verbal presentation of subject matter. These should be assembled into a book or preferrably incorporated into the CAI lesson itself.
16. Vocabulary control should be exercised to keep reading comprehension requirements generally consistent with the reading ability of typical students. All programs should be written one or two grade levels below where they are used to compensate for the slow/poor reader.
17. Care should be taken to avoid lengthy presentations prior to a call for student response. No more than three frames should be presented without some student response, exceptions being the review section of a lesson.

With these items providing some insight into the nature of the CAI materials, let's now examine the flow chart for a given lesson. Be aware that the system manages student learning by three aptitude or learning levels.

CAI Flow Chart

In order to better understand the nature of a lesson or program presentation, you might think of a presentation which includes three basic elements: (a) a pretest, (b) a lesson sequence and (c) post-test (see Figure 1). An explanation of each of these major elements is in order.

The Pretest Element of the lesson contributes to increasing the efficiency of instruction. In order to provide assurance that this element of the lesson performs its task effectively, several guidlines control its construction. These include:

1. The pretest should reflect the terminal performance and enabling objectives for the lesson and should consist of test items which are alternate forms of the items used in the lesson review element post-test. This procedure provides reasonable assurance that students who passed the pretest have demonstrated the same mastery of the objectives as those students who go through the related lesson and pass the lesson review post-test.
2. The test items should be assembled in random order to diminish transfer effects among items.
3. The pass-fail standard for any pretest should be no lower than 80%. Students who pass the pretest at a level below 100% should be given instruction or review pertinent to the test items which they missed before being allowed to proceed to the post test or lesson.

4. The number of items in each pretest should be sufficient to assure reasonable test reliability. Eight (8) test items are the suggested minimum number of questions in a given pretest. Ten (10) is the sufficient for a 30-45 minute lesson.
5. Maximum use should be made of multiple-choice items. However, fill-in or constructed response test items are permitted if achievement of the relevant objectives can be tested with greater validity by these types of test items.
6. Each pretest item should include an "I don't know" alternative to minimize guessing.
7. Cues, hints or suggestions should not be employed in the context of the pretest items.

The Lesson Element is the most critical component of the instructional model because of its function to impart the required skills and knowledges requisite to the achievement of the objectives. Success to this end is dependent primarily on the ability of the instructional programmer to construct effective and efficient course materials. Keyed to this process are the instructional strategies and techniques which can be employed within the model. Furthermore, the only limitation to the sophistication of the strategies is the capability of the instructional programmer.

The fundamental instructional strategy employed in this system is tutorial dialogue. The power of the computer to approximate the role of

a live instructor should be exploited to the maximum extent possible. Great use should be made of the branching, recycling, looping and other techniques to adapt the instruction to the specific individual needs of the student. Inherent to this entire process is the careful integration of information and respone frames to facilitate learning.

Instructional Sub-Element

The instructional sub-element is the basic teaching unit within the model (see Figure 1). Each sub-element includes a preconditioning sequence, conditioning chain and prover unit.

1. Preconditioning sequence. This sequence should consist o. one or more information frames which serve a two-fold purpose. First, to introduce students to the subject matter presented in the conditioning chain and second, to function as part of the forward branching procedure for high aptitude students. This sequence contains information frames only. Although information frames do not call for a response, they serve a vital function in providing critical information or cues prior to a response frame and thereby provide reasonable assurance of a correct answer on the first attempt.
2. Conditioning chain. This sequence should consist of information and response frames, integrated in a sequence that enables the student to master the objective reflected in the prover unit. The information frames are similar to the ones already

described. The response frames are of two types, namely, multiple choice and fill-in (constructed). For the most part multiple choice frames are used because their structure permits easier entry by the student and programming by the teacher.

Furthermore, it has been determined that multiple choice response frames are just as effective as constructed response frames from an instructional viewpoint. However, constructed response frames can be used whenever the instructional programmer feels their use is merited (U.S. Continental Army Command, 1972). Teaching a new term and then having the student recall rather than select the term is an example of the use of a constructed response frame. It should be noted that the information leading up to the response frame should condition the student so that 85% of all students enter the correct response on the first try. If the student responds to a frame in an incorrect manner, then there are several possible ways to give remediation. First, if the response was unknown, additional information can be given and branching back to the question is forced. Second, if the response was known but incorrect, a hint as to the proper response can be given, then at the instructional programmer's option, the student can be branched back through the frame. Third, if a student fails to answer correctly within the limits of the established criteria a number of times, the instructor is notified by the system so

that personal assistance can be given. Furthermore, correct answers should receive confirmation before the student is allowed to proceed to the next frame. It should be noted that the student must respond correctly or get personal remediation before being allowed to continue to the next incremnt of instruction. Within the conditioning chain extensive use of analogies or common examples should be used to enhance the transfer of learning to new experiences.

3. Prover unit. This sequence should consist of one or more response frames. For the most part, the instructional contingencies addressed in the logic for this type of response frame are the same as those found in a conditioning chain response frame. However, two additional special considerations are included in the prover frame logic. First, the high aptitude students who give a wrong answer to a prover frame on the first try are cycled back to the beginning of the conditioning chain. Second, an "I don't know" alternative should be included to keep guessing at a minimum level. This latter contingency is provided because of the critical nature of the prover unit frame in terms of testing for mastery of an objective. Including an "I don't know" alternative gives the student an option to receive additional information to increase his/her confidence in being able to respond correctly. As in

the case of a response frame in the conditioning chain, the student must respond correctly to a prover frame or be given instructor help before being allowed to continue.

Review Element

The review element should provide a review of the lesson material prior to the application of a post-test which is a strategic checkpoint to determine if the objectives of the lesson have been achieved and, therefore, if the student is ready for the next increment of instruction.

The crucial nature of the post-test section of the review element makes it imperative to provide effective remediation for those students whose performance does not measure up to expected standards. This is accomplished, at the instructional programmer's option, by recycling the student through the entire lesson using the proper command or by the instructor checking the enrollment log. Although a rare occurrence, it is possible for a student to fail the post-test section of the lesson a second time even after being recycled or given intensive remediation. In these rare cases the instructor personally must provide the necessary remediation to correct the noted deficiencies and thereby makes sure that the student is ready to continue his or her studies.

The guidelines for the construction of test items on the post-test are the same as those established for the pretest items. As a result, the instructional programmer must pursue extreme care in making sure of the compatibility of pretest and post-test items. This can be determined most effectively through item analysis procedures.

Most important of all, remember that the guidelines and organization given here are not by any means the total answer to all CAI problems. There are many approaches that can be taken.

For a more detailed description of how the CAI lesson selects pathways for student learning, examine the flow chart in Figure 2. To simplify the explanation, the chart has been designed to show the alternatives for two extremes of aptitude, high and low. The arrows indicate possible paths depending upon student responses or system controls programmed by the instructor.

CAI Script Preparation

Regardless of the language or system used to manage the program, the script required would contain the same information. To give some practical help to the novice programmer, the following examples are provided which are structured in line with the model previously presented. Those lines which appear in upper case represent the actual program entered into the computer. Each lesson generated needs to have descriptive data which will let the user know what the lesson is about. Some of the following information might be found in the remarks or introduction of the lesson.

1. Course for which lesson is generated.
2. Lesson name or number.
3. Code assigned to it in the data file or memory system.
4. Author's name.
5. Date lesson was written or put into the system.

6. Any specific directions or instructions related to terminal operation (clear screen commands, etc.).
7. A listing of specific objectives which will be taught in the lesson.

Some of the information is of no value to the student. In the BASIC language, a remark (REM) statement might be used to make it available to the programmer. Here is a sample of introductory type information needed by the teacher about the lesson.

Program Data (if programmed in BASIC, you could use a remark statement)

```
THIS IS LESSON #17, FOR COURSE IAT 180
WRITTEN BY D. L. JELDEN, UNC
CODE ON DISK IS 'DC POWER'
I.D. NUMBER IS THE STUDENT'S SOCIAL SECURITY #
```

The next type of introductory material is needed by the student and would be presented by the computer.

```
PLEASE TYPE IN YOUR ID NUMBER.
TO CONTINUE THE LESSON, PUSH THE RETURN KEY.
```

Instructional Data

```
                D.C. POWER
          LESSON OBJECTIVES

1. HOW TO DEFINE THE TERMS WORK, FORCE, ENERGY AND POWER.
2. HOW TO DETERMINE THE POWER USED BY A RESISTOR IN A D.C.
   CIRCUIT.
3. HOW TO DETERMINE THE TOTAL POWER USED IN A D.C. CIRCUIT.
```

Directions

```
I WOULD LIKE TO GIVE YOU A BRIEF PRETEST OVER THESE OBJECTIVES.
THE PURPOSE OF THE PRETEST IS TO PERMIT YOU TO SKIP THE LESSON IF
YOU ALREADY KNOW THE MATERIAL.
```

THIS PRETEST COVERS ALL THE INFORMATION TAUGHT IN THE LESSON.
DO NOT GUESS OR TAKE TOO MUCH TIME WITH ANY ONE QUESTION.

PUSH THE RETURN KEY TO CONTINUE.

The Pretest

The pretest element usually consists of objective type questions. To bypass the instructional phase or lesson element, a score of at least 80% is required on the pretest. For those items missed on the pretest, additional instruction or review should be given prior to the post test. To give you an idea of some sample pre/post test items, here are two sample questions:

PRETEST
D.C. POWER

1. WHICH OF THE FOLLOWING PHRASES BEST DEFINES ELECTRICAL POWER?
   A. TIME RATE AT WHICH WORK IS DONE.
   B. MOVING AN OBJECT BY APPLYING FORCE.
   C. CAPACITY TO DO WORK.
   D. DIFFERENCE IN POTENTIAL.

   (TYPE IN THE LETTER OT YOUR CORRECT ANSWER AND PUSH THE RETURN KEY.)

2. IN WHAT FORM IS POWER USED BY A RESISTOR?
   A. MOVEMENT OF ELECTRONS.
   B. LIGHT.
   C. HEAT.
   D. FRICTION.

The program can be written to show the students if they answered the test items correctly or not. Research indicates that students want to know how they did and what the correct answer was if they missed it. Another point of view was that a pretest item should be used to determine

competency only. Providing feedback on each test item of the pretest is a decision each author must make (Jelden, 1981b).

At the conclusion of the pretest, a scoring program would be activated. Based on the scores of the examination, the management program would then determine the options available to the student, such as pass/fail or progress in the lesson. Two possible options might be as follows:

Score 80% or Above

YOUR SCORE ON THE PRETEST WAS HIGH ENOUGH TO ALLOW YOU TO SKIP THE LESSON. YOU MAY NOW EITHER TAKE THE LESSON OR THE POST-TEST. TYPE "A" FOR THE LESSON OR "B" FOR THE LESSON REVIEW AND POST-TEST.

Score 79% or Less

I'M SORRY (NAME), YOUR SCORE ON THE PRETEST WILL NOT ALLOW YOU TO SKIP THE LESSON. PUSH THE RETURN KEY AND WE'LL GET ON WITH IT. DO WELL, AND I'LL SHORTEN YOUR TIME IN THE LESSON. HOW'S THAT FOR BEING A NICE GUY?

The Lesson Element

As stated earlier, the major block of the instructional program is the lesson element. It consists of the instructional sub-element, pre-conditioning sequence, conditioning chain with remediation and prover unit with remediation. To provide you with some examples of each of these segments, the following script is presented with each part identified.

Instructional Sub-Element (information only)

POWER IS DEFINED AS:

THE TIME RATE AT WHICH WORK IS DONE, OR THE TIME RATE AT WHICH ENERGY IS USED. IN AN ELECTRICAL CIRCUIT THE WORK DONE IS THE FORCING OF ELECTRONS THROUGH THE CIRCUIT BY THE APPLIED VOLTAGE.

Preconditioning (information only)

WORK IS PERFORMED ANY TIME AN OBJECT IS MOVED BY THE APPLICATION OF FORCE.

Conditioning Chain (analogy)

IF YOUR CAR WERE TO RUN OUT OF GAS, YOU WOULD HAVE TO PUSH IT TO THE SIDE OF THE ROAD. PUSHING THE CAR WOULD BE A FORM OF ---?---.

A. WORK
B. FORCE
C. ENERGY

CHOOSE THE CORRECT ANSWER AND TYPE A, B OR C.

If the student answered "FORCE" or "ENERGY," the following remediations would be given.

Wrong Answers (remediation to specific wrong answer recycle)

NO, THE FORCE IS WHAT YOU APPLY TO THE CAR WHEN YOU PUT YOUR SHOULDER AGAINST IT AND PUSH. TRY AGAIN.

WRONG, THE ENERGY IS YOUR OWN ABILITY TO PUSH THE CAR. IF YOU DON'T HAVE ANY ENERGY, YOU CAN'T MOVE THE CAR. TRY AGAIN.

If the student answered "WORK," then the student would be given support to that correct answer. Occasionally, you could give additional information with the right answer. It might work as follows:

Correct Answer (plus support)

WORK. RIGHT, AND THE BIGGER THE CAR, THE MORE WORK YOU MUST DO.

Note that with the use of a support statement to a correct answer, the learning is reinforced and provides for greater retention of the

concept. The conditioning chain is designed to give the student a chance to make a connection between information which they probably now possess and interconnect it to the new concept under study. In our example, it assumes most people have had experience in pushing a car. In doing so, they did work. By using this example, students should then see the connection between this experience and the forcing of electrons through a circuit which is another form of work.

To find out if this connection has been made, a "prover unit" example is provided which calls for the student to respond to the new concept presented--that example being the definition of work as it is used in electrical application. The prover unit can be stated as follows:

Prover Unit

WHEN WE CAUSE ELECTRONS TO MOVE TRHOUGH A CIRCUIT BY APPLYING A VOLTAGE, ---?--- IS BEING DONE.

A. WORK
B. FORCE
C. ENERGY

CHOOSE THE CORRECT ANSWER AND TYPE A, B OR C.

As with the conditioning chain, the anticipated response is provided with each possible answer. The wrong answer would have additional remediation statements with it so the student would be told why the answer selected is wrong. From this experience, the learning can be enhanced, even by the selection of wrong answers. Examples of the wrong answer remediation and the reinforcement of the correct answer follow:

Wrong Answer (with remediation)

COME ON. WE'VE ALREADY SAID THAT FORCE IS A PRESSURE APPLIED TO AN OBJECT TO MAKE IT MOVE. TRY AGAIN.

NO, NO. ONCE AGAIN, THE ENERGY WOULD BE THE ABILITY OF THE VOLTAGE TO CAUSE MOVEMENT OF ELECTRONS. TRY AGAIN.

Correct Answer (with remediation)

WORK, CORRECT. ANY TIME ANY OBJECT IS MOVED BY ANY FORCE, WORK IS PERFORMED.

The preconditioning, conditioning and prover unit sequence would be repeated for each new sub-element or major element of information found in the lesson. For each incorrect response in the conditioning chain and in the prover unit, remediation would be given. This remediation could be as simple as adding information in the anticipated response items or as complex as another full preconditioning, conditioning and prover unit added to the incorrect answer. If this latter choice is used, it becomes a type of modified branching which adds additional learning to the program beyond that stated in the objectives of the lesson. In any case, it provides an opportunity for the learner to not only reach the objectives of the lesson, but will teach all the other enabling objectives required to achieve it as well. It is this flexibility, managed by the program system that make CAI so effective.

Review Element

The review element of the program generally consists of a summary of items or sub-elements covered in the lesson in statement form.

The purpose of the summary is to print out in condensed form the major concepts or ideas taught in the lesson. In the main, these statements are a collection of the instructional sub-elements or parts of the preconditioning information. Below are some examples of the "summary" items.

SUMMARY

1. POWER IS THE TIME RATE AT WHICH WORK IS DONE OR ENERGY IS USED.
2. ELECTRICAL POWER IS MEASURED IN WATTS.
3. WORK IS PERFORMED ANY TIME AN OBJECT IS MOVED BY THE APPLICATION OF FORCE.

In a classroom environment which has a printer, experience has shown that students like to have a print-out of these statements for review purposes, not only for taking the lesson pre/post tests, but also for studying for the comprehensive exams for the course. This listing provides a collection of concepts taught in the lessons from which the test questions are generated. In this form they are equally as useful for the teacher who must write the comprehensive tests (Jelden, 1981a).

Dot Commands

To implement a usable programming language for CAI on a microcomputer, a management program was written called ISSCAI. The heart of the CAI "coursewriter" system is the use of dot commands which are placed at strategic points within the scripts. A collection of dot commands available follows. These commands are placed at the beginning of a line, within the text of a lesson. If the first character of any

C A I MODEL

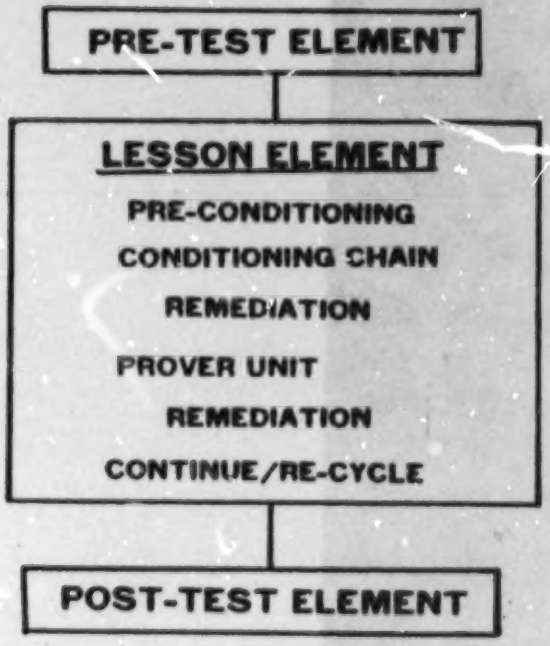

FIGURE 1

```
.LB
.ANW
COME ON.  WE'VE ALREADY SAID THAT FORCE IS A PRESSURE APPLIED TO AN
OBJECT TO MAKE IT MOVE.
.LB
.ANW
NO, NO.  ONCE AGAIN, THE ENERGY WOULD BE THE ABILITY OF THE VOLTAGE
TO CAUSE MOVEMENT OF ELECTRONS.
.LB
.ANC
WORK.  CORRECT.  ANY TIME ANY OBJECT IS MOVED BY FORCE WORK IS
PERFORMED.
```

Greater detail about the system is not possible in this brief presentation. Just be aware that all of the management and recordkeeping functions available within the system can be contained and operated in approximately 8K of CPU memory space in the microcomputer. With this system approximately one third of the programming space is saved when comparing the same program written with the BASIC language. ISSCAI is also far supeior to BASIC in the simplicity of programming scripts and teacher data entry.

SUMMARY

With the advent of the microcomputer, more classroom and educational applications of it are likely in the future. The ability of the computer to present and manage data for the educational purposes is great. The main factor of CAI, however, is the quality of the material put into the system. With a valid CAI model to follow, the pretest element, the lesson elements and the review element do an effective job of teaching. Students who learn quickly can skip the conditioning sequence and go directly to the prover units within the lessons. Those who need extra

help can receive it without slowing down the more capable students. Those students who need some additional support for selected items can receive it also. The large degree of flexibility within the system, however, is still related to the teacher's ability to write clear, meaningful instructional lessons. The author must take into consideration and anticipate the entry of the wrong answers some students may make. The teacher's ability to analyze, construct and implement valid lessons which anticipate student learning problems becomes the key factor ensuring CAI effectiveness in the classroom. Extended applications of the microcomputer in the future for tutorial interactive instruction programs can be expected. Even time-share microcomputer systems currently on the market make the expansion of CAI tutorial instruction within reason, economically.

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SIMPLIFIED TUTORIAL PROGRAMMING FOR INTERACTIVE CAI MATERIALS

by D. L. Jelden

Introduction (Abstract)

This paper is a continuation of an article written in the spring 1981 issue of the AEDS Journal which describes the microcomputer version of an educational model and the simplified dot commands which control interactive tutorial instruction. This presentation will show how the script generation is accomplished and how the utilization of the dot commands for the lesson can simplify programming problems, reduce computer memory capacity and manipulate students on unique pathways through the CAI lesson for the most effective and efficient learning experience in any subject field.

This paper explains the modification of a validated instructional model generated on a large mainframe computer by the military to a microcomputer format. The general integrity of the model is maintained as the transition is made to the microcomputer system.